Research and Development of Hydrogen Fueled Future Space Transportation Systems

Report Number: R24EDG10105
Subject Category: Research and Development
URL: https://www.jss.jaxa.jp/en/ar/e2024/27154/

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Abstract

High speed point to point (P2P) space transportation system seems to be promising in the community of future private space businesses. In this project, we aim at completing hydrogen fueled hypersonic engine technology, especially, control techniques changing two cycles between turbojet and scramjet engines for the combined cycle engines and transferring the technology to the private business players. As a result, we will contribute to realize the above mentioned space transportation system.

Reasons and benefits of using JAXA Supercomputer System

When hydrogen fueled hypersonic engines are used for space transportation systems, It is necessary to confirm the engine working characteristics in the wide range of flight speeds while a vehicle with the engine is accelerating and ascending. However, it is impossible to simulate all the flight conditions by ground experiment facilities so that the use of CFD is indispensable to compensate for the experiment. In addition, considering the change of engine cycles for the turbine based combined cycle engine, it is necessary to investigate not only each the engine performance, but also the entire engine system. For this purpose, the application of advanced optimization algorithms using CFD database is effective. Therefore, it is indispensable to utilize JSS since numerous computational resources are required to handle those subjects efficiently.

Achievements of the Year

RANS simulations have been conducted in a rectangular combustor with an angled hole injector using a commercial CFD solver CFD++ to investigate optimum interaction of shock wave and injection jet for efficient fuel mixing enhancement. Parametric study has been performed varying location of shock wave interaction, injection pressure, and injection angle. It has been found that effective mixing enhancement is achieved when air enters from the side of the jet through the recirculation region downstream of the jet caused by the incidence of a shock wave, as shown in Fig. 1.

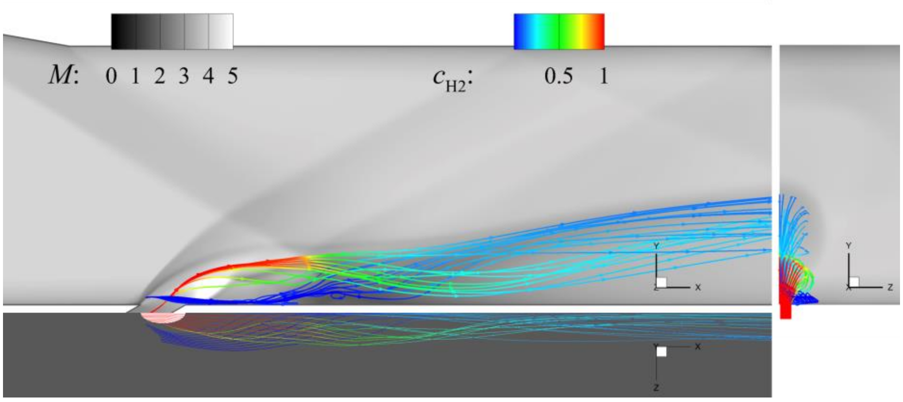

Fig. 1: Shock structures and streamlines around injector

- **Publications**

  N/A

- **Usage of JSS**

- **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	8 - 16
Elapsed Time per Case	24 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources*1(%): 1.05

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage*2(%)
TOKI-SORA	1,596,128.32	0.07
TOKI-ST	7,012,591.19	7.20
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	0.00	0.00
TOKI-TST	0.00	0.00
TOKI-TGP	0.00	0.00
TOKI-TLM	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2] (%)
/home	95.36	0.06
/data and /data2	32,420.36	0.16
/ssd	0.00	0.00

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2] (%)
J-SPACE	4.58	0.01

[*1]: Fraction of Usage in Total Resources: Weighted average of three resource types (Computing, File System, and Archiver).

[*2]: Fraction of Usage：Percentage of usage relative to each resource used in one year.

- **ISV Software Licenses Used**

ISV Software Licenses Resources		
	ISV Software Licenses Used (Hours)	Fraction of Usage[*2] (%)
ISV Software Licenses (Total)	11,402.93	7.79

[*2]: Fraction of Usage：Percentage of usage relative to each resource used in one year.